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B2E
B2L

(54) A method of applying magnetic media to a disk

(57) A method of applying magnetic media to a disk, comprises the steps of: rotating a disk (10) having an inside diameter (14) and an outside diameter (15) and a central opening (12) at a rotational speed of at least 3000 rpm during a high speed coating application step, applying magnetic media to the disk from a nozzle (20) moveably mounted with respect to said disk between said outside diameter and said inside diameter during said coating application step as the nozzle moves between the outside diameter and said inside diameter; and reducing the rotational speed of the disk during an orientation step immediately following the coating application step, the disk being exposed to a magnetically orienting field during the orientation step.

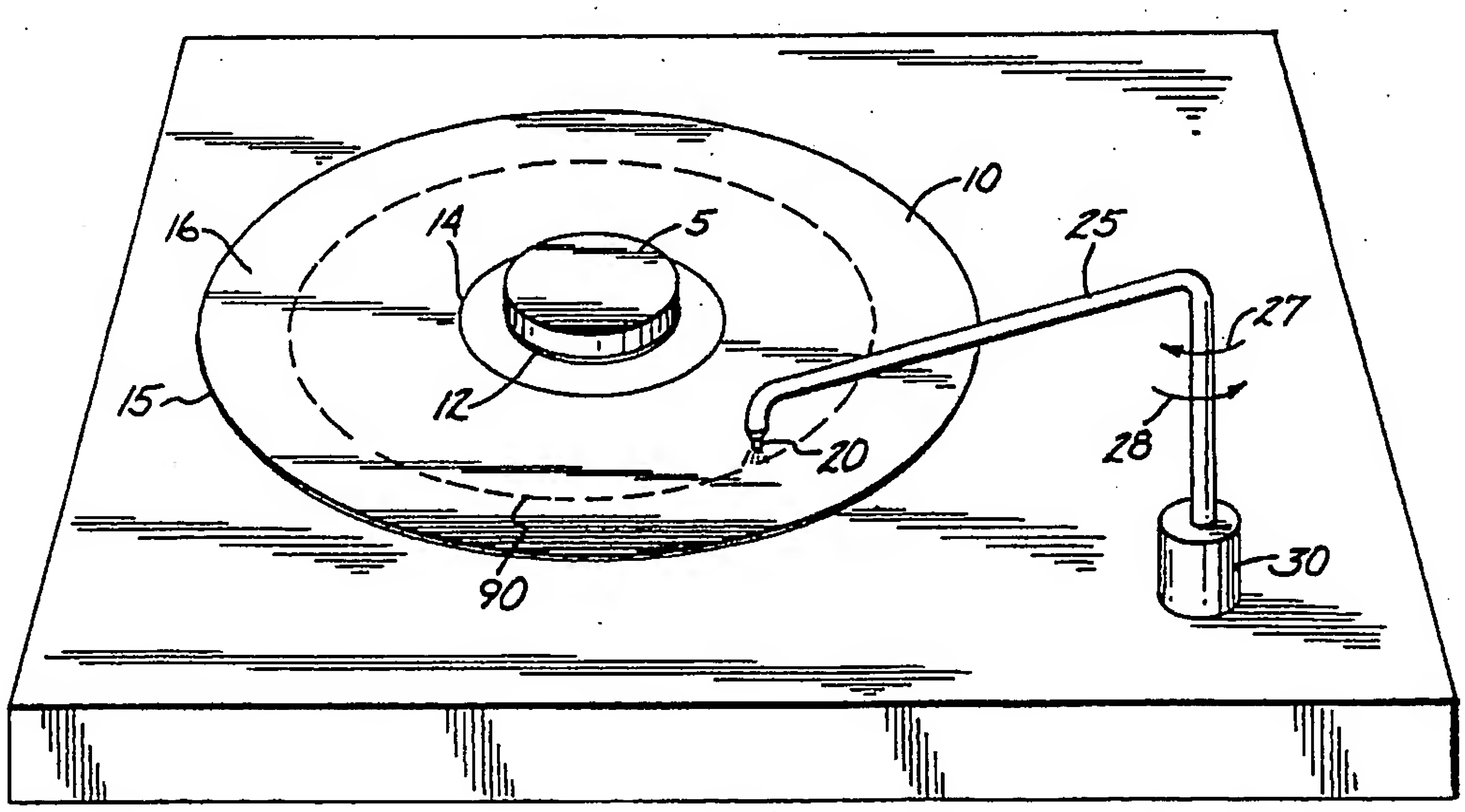

Fig.1

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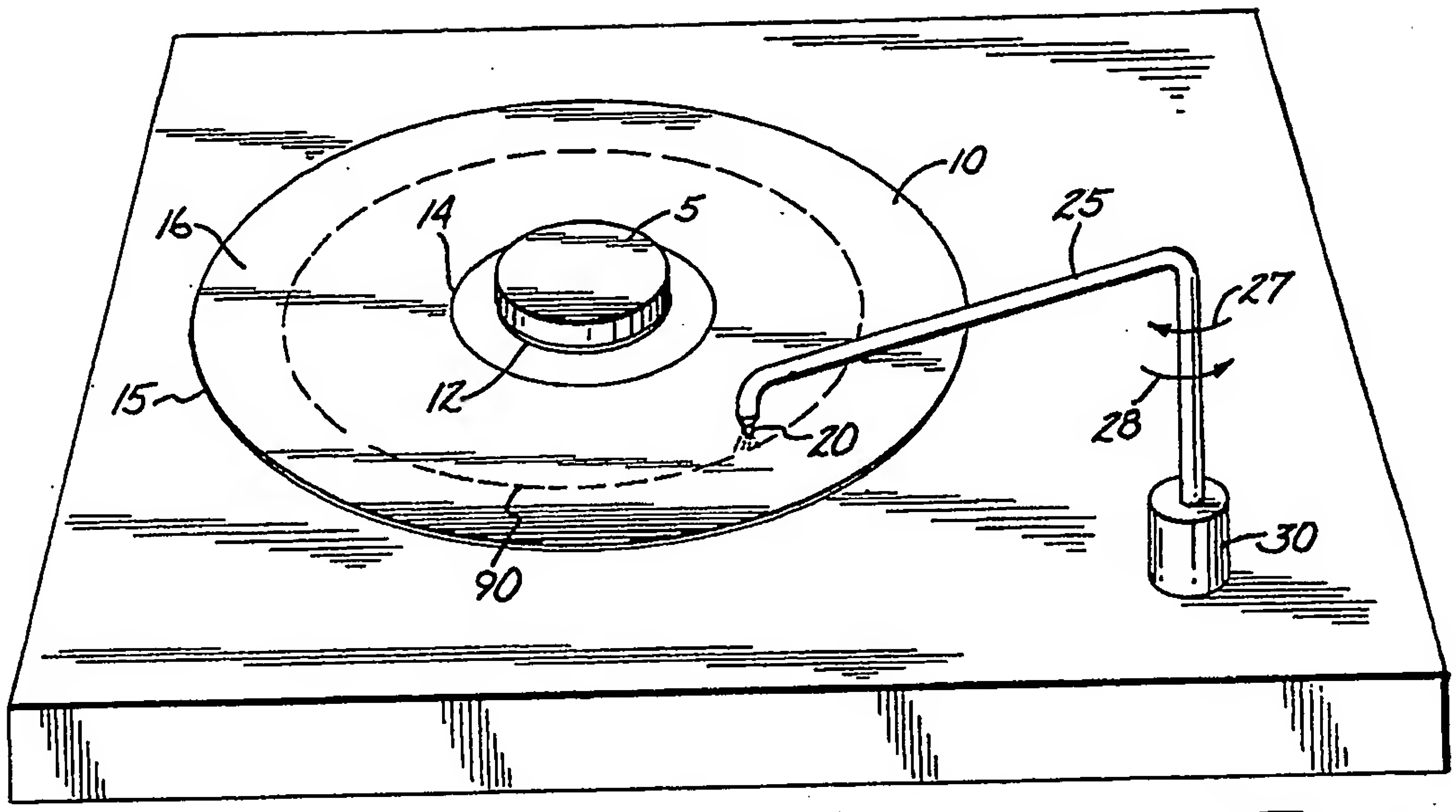


Fig.1

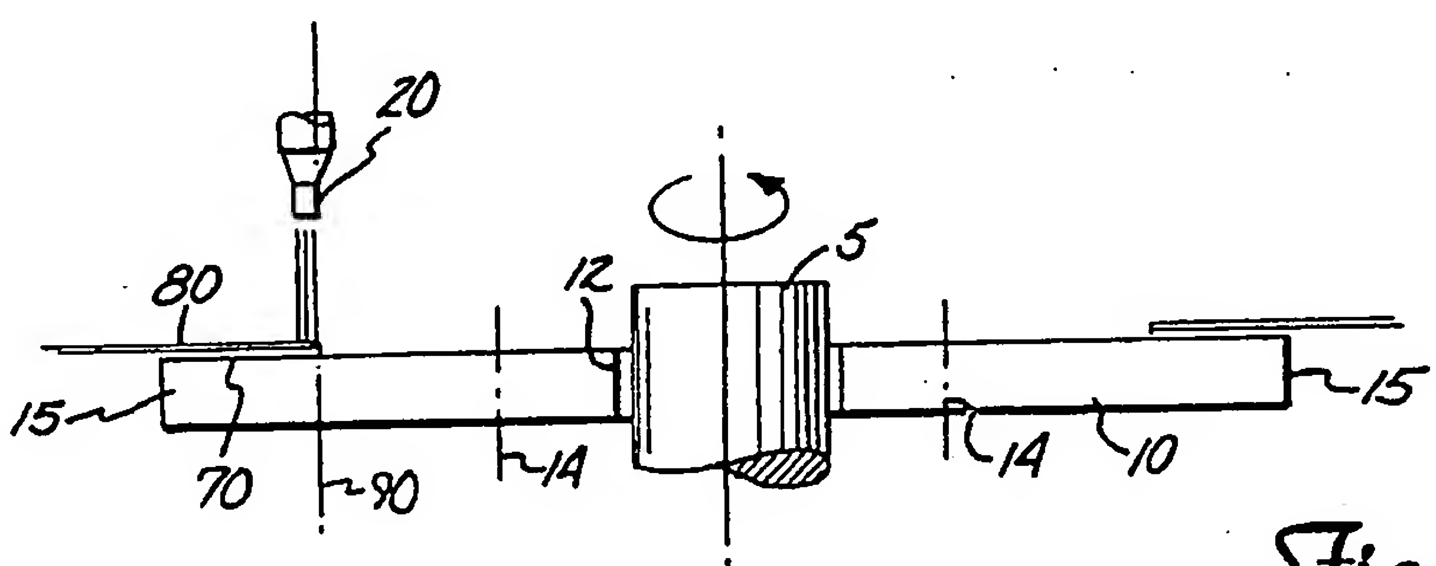


Fig.4

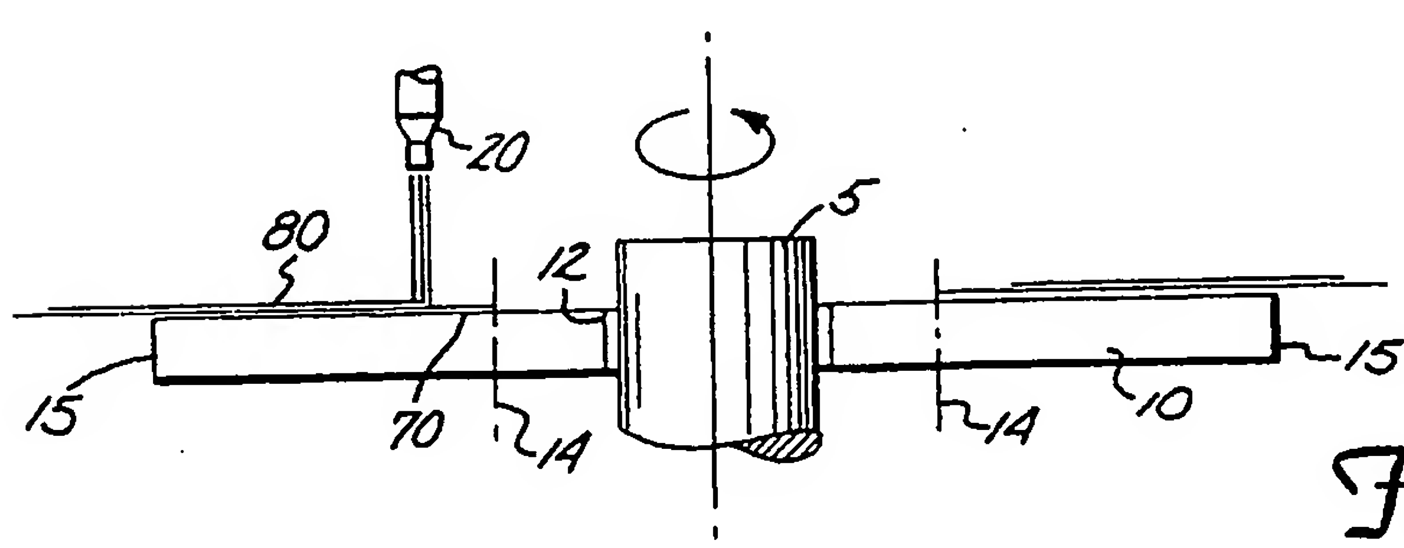


Fig.5

Fig.2

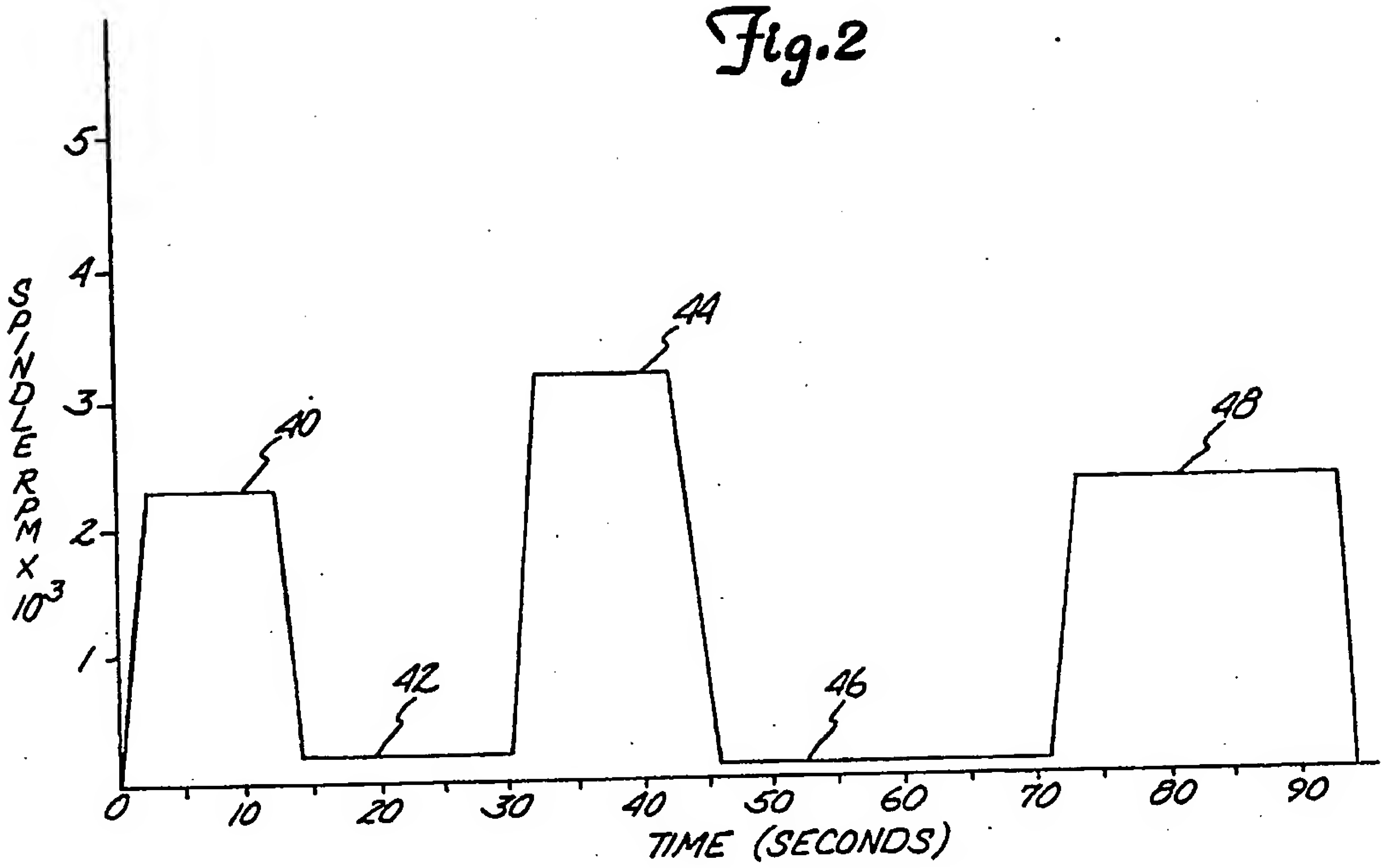
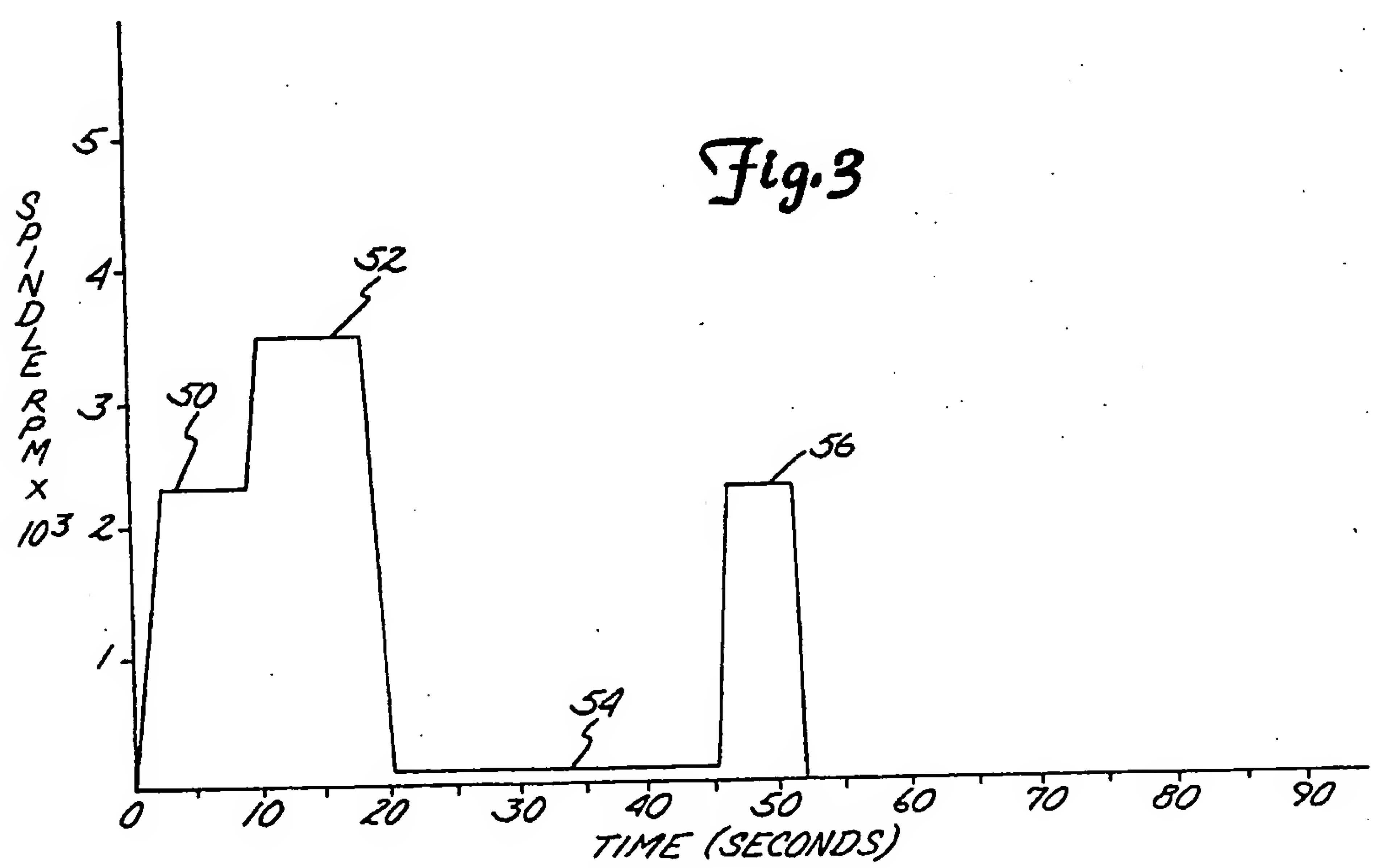

5
4
3
2
1
SPINDLE RPM x 10³
40
42
44
46
48
0
10
20
30
40
50
60
70
80
90
TIME (SECONDS)

Fig.3


5
4
3
2
1
SPINDLE RPM x 10³
50
52
54
56
0
10
20
30
40
50
60
70
80
90
TIME (SECONDS)

SPECIFICATION

A method of applying magnetic media to a disk

BACKGROUND

The invention relates to methods of applying magnetic media to disks.

In the past, magnetic media has typically been applied to a disk while the disk is rotated at low speed, with the speed of the disk then being increased during a high speed spin-out step to spin excess magnetic media off of the disk by means of centrifugal force. The disk then went through a magetic orientation step and a drying step before being baked and polished. The polishing was done both to improve surface finish of the disk and to reduce the thickness of the film of magnetic media applied to the disk.

Since the magnetic media was applied to the disk at a very low speed, the magetic media would undergo very rapid viscosity changes prior to the high speed spin-out step which resulted in a relatively thick film of magnetic media ultimately adhering to the disk.

The conventional method also provided ample opportunity for air-borne particles to settle on the disk and later cause radially directed runs to form during the high speed spin-out step as the magnetic media would attempt to flow around the particle as excess media was spun off the disk. In addition, circumferentially directed scratches were caused during the polishing operation where a particle was picked up by a polishing tape. Furthermore, coating flaws known as "wraparounds" occurred where the magnetic media flows from one side of the disk around the edge to the other side of the disk.

The present invention seeks to avoid the above-mentioned problems by providing a thin film magnetic coating of high quality surface finish such that the existing post-coating polishing operation can be eliminated.

Although the present invention is primarily directed to any novel integer or step, or combination of integers or steps, herein disclosed and/or as shown in the accompanying drawings, nevertheless, according to one particular aspect of the present invention to which, however, the invention is in no way restricted, there is provided a method of applying magnetic media to a disk, comprising the steps of: rotating a disk having an inside diameter and an outside diameter and a central opening at a rotational speed of at least 3000 rpm during a high speed coating application step, applying magnetic media to said disk from a nozzle moveably mounted with respect to said disk between said outside diameter and said inside diameter during said coating application step as said nozzle moves between said outside diameter and said inside diameter; and reducing the rotational speed of said disk during an orientation step immediately following said coating application step, said disk being exposed to a magnetically orienting field during said orientation step.

Preferably said magnetic media is dispensed from said nozzle at a fixed nozzle discharge pressure of at least 4200 kg/m (6 psig) during said coating application step.

In the preferred embodiment at the start of said coating application step, said nozzle begins dispensing magnetic media at said outside diameter of said disk and moves towards said inside diameter of said disk and returns from said inside diameter of said disk to said outside diameter of said disk at the end of said coating application step. For example, as said nozzle moves from said outside diameter towards said inside diameter during said coating application step, a thin film of magnetic media adheres to said disk and a protective layer of excess magetic media flows over said thin film in a radially outward direction away from said nozzle due to the centrifugal force of said rotating disk, said protective layer extending from said inside diameter to said outside diameter once said nozzle reaches said inside diameter, said protective layer advancing towards said outside diameter with said nozzle and exposing said thin film as said nozzle moves from said inside diameter to said outside diameter. Preferably once said nozzle has moved from said outside diameter to said inside diameter during said coating application step, said nozzle pauses for a period of approximately one second before returning from said inside diameter to said outside diameter.

Said nozzle may have a rate of travel while moving from said outside diameter to said inside diameter during said coating application step of between 2.5 cm/sec (1.0 inch/sec) and 3.8 cm/sec (1.5 inch/sec).

The method may include a drying step following said orientation step, the rotational speed of said disk being increased during said drying step.

Said coating application step may have a duration of between 7 seconds and 10 seconds.

Preferably said rotational speed during said coating application step is in a range between 3000 rpm and 3800 rpm.

In the illustrated embodiment during said coating application step the magetic media is dispensed from said nozzle at a nozzle pressure within the range of 4200 to 5600 kg/m^2 (6 to 8 psig).

According to a further non-restrictive aspect of the present invention there is provided a disk having magnetic media applied thereto by a method as recited above.

The invention is illustrated, merely by way of example, in the accompanying drawings, in

which:

Figure 1 is a persepctive view of a simplified magnetic coating apparatus on which a method according to the present invention can be performed;

Figure 2 shows graphically the relationship between disk rotational speed and time of a known method of applying magnetic media to a disk;

Figure 3 shows graphically the relationship between disk rotational speed and time for a method according to the present invention of applying magnetic media to a disk;

Figure 4 is a cross-sectional elevational view showing a nozzle of the apparatus applying magnetic media to a disk and moving from an outside diameter of the disk towards an inside diameter; and

Figure 5 is a cross-sectional elevational view showing the nozzle of Figure 4 applying magetic media to the disk while returning from the inside diameter of the disk and moving towards the outside diameter of the disk.

Figure 1 shows a simplified disk coating apparatus on which a method according to the present invention can be performed. Only the very basic structure of the apparatus is important in describing the present invention, and tberefore, details of the apparatus are not shown. The apparatus includes a rotatable spindle 5 which has a variable rotational speed of at least 3000 rpm up to, for example, at least 3800 rpm. The spindle 5 is rotated by a power source (not shown). A disk 10 upon which magnetic media is to be applied has a central aperture 12 which is secured for rotation to spindle 5 by any suitable mechanism (not shown). The disk 10 has an inside diameter 14 and an outside diameter 15 which define a concentric region 16 of the disk 10 upon which magnetic media will be applied. A magnetic media dispensing nozzle 20 is supported by an arm 25 which is in turn pivoted by a motor 30 under the control of a control system (not shown). The arm 25 includes a fluid conduit (not shown) which connects the nozzle 20 to a pressurized source of fluid magnetic media (not shown). In the preferred embodiment the discharge opening at the tip of nozzle 20 is approximately 0.05 cm (0.02 inch). The arm 25 is pivotable by the motor 30 in the direction of arrows 27, 28 so that the nozzle 20 can travel from the outside diameter 15 to the inside diameter 14 and back again. The control system for the motor 30 determines the rate of travel of tbe nozzle 20 across the disk 10. A mechanism may be provided to vary the discharge pressure of magetic media through the nozzle 20.

Having disclosed the basic structure of the apparatus, reference is now made to Figure 2 wherein a known method using the apparatus of Figure 1 is illustrated by means of a graph showing disk rotational speed versus time.

According to the known method of Figure 2, the disk is first rotated at approximately 2300 rpm for 10 seconds during a step 40 while the disk is lightly wiped with a lint-free cloth saturated with a cleaning solution to free the surface from any air-borne fines or particulates. The speed of the disk is reduced to 150-250 rmp for 16-18 seconds in a step 42 while the magetic media is supplied by means of the nozzle 20 as the nozzle moves from the outside diameter 15 to inside diameter 19 and then back to the outside diameter 15. The discharge pressure of nozzle 20 is approximately 1400 to 2100 kg/m² (2.0 to 3.0 psig). Step 44 is a high speed spin-out step wherein the speed of the disk is increased to 3000-3400 rpm for approximately 8-12 seconds to spin excess media off of the disk and thereby define the thickness of a magnetic film applied to the disk. In an orientation step 46, the speed of the disk is reduced to 50-60 rpm for 15-25 seconds while the disk is immersed in a magnetic orienting field to attempt properly to orient the magnetic particles of the magnetic film just applied to the disk. In a drying step 48, the speed of the disk is increased to 2300 rpm for 20-25 seconds to accelerate the drying of the magnetic film. Next, the disk is processed through conventional baking and polishing steps.

Having described the known method of Figure 2, a method according to the present invention will be described in relation to Figure 3. This method also begins with a solvent washing step 50 during which the disk is rotated at 2300 rpm approximately for 10 second approximately while it is lightly wiped with a lint-free cloth saturated with a cleaning solvent to free the surface of any air-borne fines or particulates. Hopefully, this step can be eliminated in the future through better disk handling procedures prior to the disk 10 being placed on the spindle 5. Immediately following the step 50, the speed of the disk is increased in a step 52 to 3000-3800 rpm approximately for 8-9 seconds approximately while the nozzle 20 dispenses magnetic media at a nozzle discharge pressure of 4200 to 5600 kg/m² (6 to 8 psig) approximately starting at the outside diameter 15 and moving to the inside diameter 14, pausing at the inside dianeter 14 for approximately 1 second, and then returning to the outside diameter 15 at a rate of travel of approximately 3 cm/sec (1.2 inch/sec).

Figures 4 and 5 illustrate the application of the fluid magnetic media to the disk 10 during the step 52. The fluid magetic media comprises iron oxide particles suspended in a polymeric binder composition. As shown in Figure 4, as the nozzle 20 moves from the outside diameter 15 towards the inside diameter 14 a thin film 70 of magentic media adheres to the surface of the disk while an excess or nonadhering layer 80 of magnetic

media flows from a point 90 of travel of the nozzle radially outward towards the outside diameter 15 and then off of the disk 10 due to the centrifugal force generated by the high rotational speed of the disk 10. The high speed rotation of the disk 10 ensures that only the thin film 70 of magnetic media adheres to the disk and in addition ensures that the excess layer 80 extends over the entire concentrically shaped disk surface disposed radially outward from the point 90 of travel of the nozzle 20. The excess media layer 80 acts as a protective layer while the nozzle 20 moves from the outside diameter 15 to the inside diameter 14 preventing the thin film 70 from evaporating and undergoing rapid viscosity changes. Once the nozzle 20 reaches the inside diameter 14, it pauses momentarily (approximately 1 second) to ensure that the edge of the thin film 70 is well-defined at the inside diameter 14. The nozzle 20 then moves radially outward back towards the outside diameter 15. As shown in Figure 5, as the nozzle 20 moves back towards the outside diameter 15, the excess layer 80 also advances back towards the outside diameter 15 exposing the thin film 70 to the atmosphere. The rate of travel of the nozzle 20 is approximately 3 cm/sec (1.2 inch/sec). Once the nozzle 20 has reached the outside diameter 15, the disk is immediately moved into the orientation step 54 of Figure 3 wherein the speed of disk 10 is reduced to approximately 52 rpm for 10-15 seconds while the disk 10 is exposed to a magnetic orienting field. Note that the disk is exposed to the magnetic orienting field only seconds after the first portions of the thin film 70 are exposed to the atmosphere. Consequently, only minimal evaporation and changes in viscosity take place from tbe time the magnetic media is first applied to the disk 10 and exposed to the atmosphere to the start of the orientation step. As a result, the magnetic particles of the thin film 70 are much more susceptible to complete orientation along the lines of the magetic orientation field than was possible with the known method. Consequently, the quality of the magnetic media in the finished product is improved and superior characteristics for magetic recording result.

A very short drying step 56 follows the orientation step 54 with the disk being rotated for no more than 5 seconds at 2300 rpm (approximately) in the absence of the magnetic orienting field to accelerate drying. The media film 70 produced by the instant process is much thinner 2.5 to 5.0 $\times$ 10^{-6} cm (10 to 20 μ inch) than was possible with the known method (7.5 $\times$ $10^{-8} - 30$ μ inch). Consequently, the thin film 70 dries much faster than was previously the case and the drying step 56 is considerably shortened and may even be eliminated.

The above described method according to the present invention is shorter in time than the known method (55 second as compared to 95 seconds). Consequently, production is increased. More importantly, however, this reduced cycle time reduces the period of time that the disk is exposed to atmospheric contaminants and hence coating contamination due to air-borne particles is reduced. This is especially true given the fact that since the coating provided by a method according to the present invention is much thinner than was possible before, it dries much faster, and therefore, is in what is known of as a tacky condition for a much shorter period of time. It is while the disk is in a tacky condition that it is most susceptible to contamination from airborne particles which fall upon and stick to the film of magnetic media. Since the thin film of magnetic media 70 dries quickly, airborne particles which fall upon it are not as likely to stick.

Particle contamination is also reduced due to the selfcleaning action of the method according to the present invention. That is, the higher discharge pressure of magnetic media through the nozzle 20 and higher rotational speed of the disk during the application of the magnetic media tends to wash away any particles which fall upon the disk. This feature eliminates coating flaws known as "runs". In the known method, if a particle were lying on the disk during the high-speed spin-out step, the magnetic media would tend to flow around the particle as it was spun radially off the disk resulting in a radially directed "run". In the method according to the present invention, such particles are generally washed off of the disk.

Wraparound type coating flaws are also eliminated by tbe method according to the present invention. A wraparound occurs where the magnetic media flows from one side of the disk around the outside edge of the disk to the other side during application or the high-speed spin-out step. Because of the elimination of the low-speed application of magetic media and the high-speed spin-out step in favour of the high-speed application of the magnetic media, such wraparounds are prevented.

Other coating flaws are eliminated due to the fact that the method according to the present invention eliminates the post-coat polishing operation. Due to the thinness of the thin film produced and its surface quality, polishing is unnecessary. In the past, such polishing was done both to improve surface finish and to reduce the thickness of the media film. Thinner magnetic media films permit denser recording of information on the disk. Polishing was conventionally done by means of a rotatably powered abrasive nylon tape and a polishing solvent applied to the disk while it was being polished by the tape. If the tape picked up a particle lying on the

disk during the polishing operation a circumferential scratch would often result. Moreover, the polishing solvent would often introduce contaminants onto the surface of the disk and was very difficult to remove completely following the polishing operation. By eliminating the need for a polishing step, circumferential scracthes on the media and contamination caused by the polishing solvent, as well as other related problems, are also eliminated. Disks which have been produced by means of the method according to the present invention require only a light dry buffing rather than polishing with solvents.

It has been noted that a thinner magnetic film can be applied to the disk using a method according to the present invention due primarily to the high rotational speed of the disk during the application of the magnetic media and the discharge pressure of magnetic media through the nozzle 20. In the past, where the magetic media was applied at low speed, the viscosity of the media would increase rapidly as it laid on the disk exposed to the atmosphere, and hence, the magetic media flowed less freely once the high-speed spin-out step began and more magnetic media adhered to the disk during that highspeed spin-out step. Another factor which affects the thickness of the film of magnetic media applied to the disk is the travel speed of the nozzle particularly as it moves from the inside diameter 14 back to the outside diameter 15. Interestingly, where the travel of the arm 25 is slowed down, the thickness of the film is reduced. This indicates that the pressure of the stream of magnetic media discharged from the nozzle 20 digs away at the thin film 70 as the nozzle is returning from the inside diameter 14 back to the outside diameter 15 and confirms the fact that both nozzle discharge pressure and speed of travel of the arm affect the thickness of the thin film.

It is extremely important that the apparatus employed in the practice of a method according to the present invention provide for smooth travel of the nozzle 20. Where the nozzle 20 vibrates, especially in returning from the inside diameter 14 to the outside diameter 15, a corresponding thickness variation will result, appearing as a circumferential thin spot on tbe thin film 70. Consequently, while the nozzle 20 is shown to be supported by a pivoting arm 25, the invention is not limited thereto and other means of moving the nozzle 20 between the outside diameter 15 and the inside diameter 14 may be more suitable.

CLAIMS

1. A method of applying magnetic media to a disk, comprising the steps of: rotating a disk having an inside diameter and an outside diameter and a central opening at a rotational speed of at least 3000 rpm during a high speed coating application step, applying magnetic media to said disk from a nozzle moveably mounted with respect to said disk between said outside diameter and said inside diameter during said coating application step as said nozzle moves between said outside diameter and said inside diameter; and reducing the rotational speed of said disk during an orientation step immediately following said coating application step, said disk being exposed to a magnetically orienting field during said orientation step.

2. A method as claimed in claim 1 in which said magnetic media is dispensed from said nozzle at a fixed nozzle discharge pressure of at least 4200 kg/m^2 (6 psig) during said coating application step.

3. A method as claimed in claim 1 or 2 in which at the start of said coating application step, said nozzle begins dispewing magnetic media at said outside diameter of said disk and moves towards said inside diameter of said disk and returns from said inside diameter of said disk to said outside diameter of said disk at the end of said coating application step.

4. A method as claimed in claim 3 in which as said nozzle moves from said outside diameter towards said inside diameter during said coating application step, a thin film of magnetic media adheres to said disk and a protective layer of excess magetic media flows over said thin film in a radially outward direction away from said nozzle due to the centrifugal force of said rotating disk, said protective layer extending from said inside diameter to said outside diameter once said nozzle reaches said inside diameter, said protective layer advancing towards said outside diameter with said nozzle and exposing said thin film as said nozzle moves from said inside diameter to said outside diameter.

5. A method as claimed in claim 4 in which once said nozzle has moved from said outside diameter to said inside diameter during said coating application step, said nozzle pauses for a period of approximately one second before returning from said inside diameter to said outside diameter.

6. A method as claimed in claim 4 or 5 in which said nozzle has a rate of travel while moving from said outside diameter to said inside diameter during said coating application step of between 2.5 cm/sec (1.0 inch/sec) and 3.8 cm/sec (1.5 inch/sec).

7. A method as claimed in any preceding claim including a drying step following said orientation step, the rotational speed of said disk being increased during said drying step.

8. A method as claimed in any preceding claim in which said coating application step has a duration of between 7 seconds and 10 seconds.

9. A method as claimed in any preceding claim in which said rotational speed during

said coating application step is in a range between 3000 rpm and 3800 rpm.

10. A method as claimed in any preceding claim in which during said coating application step the magnetic media is dispensed from said nozzle at a nozzle pressure within the range of 4200 to 5600 kg/m^2 (6 to 8 psig).

11. A method of applying magnetic media to a disk substantially as herein described with reference to the accompanying drawings.

12. A disk having magnetic media applied thereto by a method as claimed in any preceding claim.

13. Any novel integer or step, or combination of integers or steps, hereinbefore described, irrespective of whether the present claim is within the scope of, or relates to the same or a different invention from that of, the preceding claims.

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